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Abstract. Novel host records and feeding behaviors are reported for five species in three genera of two cassidine beetle tribes, Hemisphaerotini and Imatidiini, from Ecuador. *Carludovica* Ruiz and Pav. (Cyclanthaceae) is reported as a new plant family and genus host for two species of *Spaethiella* Barber and Bridwell. *Calathea* G. Mey (Marantaceae) is reported as the first host record for *Aslamidium capense* (Herbst) and *Calathea lutea* Schult. and *Calathea majestica* (Linden) H. Kenn. are reported as the first host records for *Aslamidium semicirculare* (Olivier). Immature stages of *Demotispa elaeicola* (Aslam) are reported for the first time; larvae are external folivores and both larvae and pupae are solitary and lack exuvio-fecal shields. The adults and larvae of *D. elaeicola* feed by rasping palm fruits, a rare feeding pattern in Cassidinae.

Resumen. Se informan los registros de plantas hospederas y comportamentos de alimentación nuevos en tres gÈneros de Cassidinae de Ecuador en los tribus Hemisphaerotini y Imatidiini. Se informa de *Carludovica* Ruiz and Pav. (Cyclanthaceae) como una familia y género nuevo de hospedero para dos especies de *Spaethiella* Barber y Bridwell. Se informa de *Calathea* G. Mey (Marantaceae) como el primer registro de alimentación para *Aslamidium capense* (Herbst), y se informa de *Calathea lutea* Schult. y *Calathea majestica* (Linden) H. Kenn. como los primeros registros para *Aslamidium semicirculare* (Olivier). Los estadios inmaduros de *Demotispa elaeicola* (Aslam) son informados por la primera vez; las larvas son folivoros externos, y las larvas y pupas son solitarias y carecen escudos exuvio-faecales. Los adultos y larvas se alimentan por raspar las frutas de palmas, un patrón raro para los Cassidinae.

Introduction

Blackwelder (1946) listed 139 species in 14 tribes of Cassidinae Gyllenhal *s.l.* for the country of Ecuador. Borowiec (1996) added 79 new tortoise beetle species records. Subsequent studies described new species for Ecuador (Borowiec 1997, 1998a, b, 2000a, b; 2003, 2007; Borowiec and Dsbrowska 1997; Borowiec and Stojczew 1998; Swietojanska and Borowiec 2000), and Borowiec (1998a) listed some 200 tortoise beetles species. Fieldwork focused specifically to cassidine collection should unveil a much higher diversity in Ecuador's cassidine fauna.

Chaboo (2007) synthesized host plants, immature stages, and other biological data of Cassidinae *s.l.*, and noted that basic information was missing for the majority of species. Here we present novel biological data for five species in three genera in two tribes, Hemisphaerotini Hincks and Imatidiini Hincks.

Materials and Methods

Habitats. Author WF visited five sites during seven visits to Ecuador during 2007 and 2008:

1. *Los Ríos Province*: **Estación Experimental Tropical Pichilingue** (hereafter Pichilingue), Instituto Nacional Autónomo de Investigaciones Agropecuarias (INIAP), 4 km SW of Quevedo, Sector "La Isla", S01.09242º, W079.45860º, 61m.

2. *Los Ríos Province*: **Estación Experimental Tropical Pichilingue,** Sector "Sta. Rita," S01.07753°, W079.46464°, 71m. Beetles were examined in forest remnants flanking a dirt road in an area of test plots of cacao and coffee with a tall overstory of *Erythrina* sp. (Fabaceae; local name "poró"); there is also dense second growth in abandoned coffee plots.

3. *Los Ríos Province*: **Mocache***:* Finca La Central, S01.11088°, W079.56194°, 75m. The study site is a formerly abandoned cacao plantation that is currently under rehabilitation. Dense understory vegetation was cleared in July 2008.

4. *Pichincha Province*: **Estación Experimental Santo Domingo**, Instituto Nacional Autónomo de Investigaciones Agropecuarias (INIAP), La Concordia, S0° 12'22", W78°2'35". This area is an oil palm plantation with large palm trees and herbaceous undergrowth.

5. *Pastaza Province*: dirt road from Hwy 45 south off Puyo leading toward Canelos, S01.567858°, W077.998552°. The area is on the Amazon side of Ecuador, and the habitat was second growth rain forest along roads. This site was visited once in August, 2008 when it is the rainy season in the area.

Specimens. All specimens were collected by hand and either preserved in 70% alcohol or pinned. Specimens were loaned to the authors by INIAP. Permission to study these specimens was granted by Agencia Ecuatoriana de Aseguramiento de la Calidad del Agro (AGROCALIDAD) and will be deposited in the Museo Ecuatoriano de Ciencias Naturales, Quito, Ecuador. Images were taken with a Canon PowerShot™ camera. Measurements were taken from head to elytral apex along the dorsal midline, and excluding the antenna.

Results

Tribe Hemisphaerotini Hincks

Spaethiella species 1 (Fig. 1–2)

Collecting data. Ecuador: Los Ríos Province: Estación Experimental Tropical Pichilingue, Sector La Isla, 15–VII–2007, 18–II–2008, 16–II–2008, 16–VII–2008, 15–VIII–2008, R.W. Flowers, R. Troya ; EETP, Sector Santa Rita, Mocache, Finca La Central, 10–VII–2008, 6–VIII–2008, R.W. Flowers, J. Cedeño. This is a new species that will be described by Lukas Sekerka (L. Sekerka, pers. comm.).

Host plant. *Heliconia latispatha* Benth. (Heliconiaceae) (Fig. 1, 2). In Pichilingue, the host is a common roadside plant, and leaves generally have two to eight beetles on their undersides. Damage consisted of narrow trenches following the leaf veins. In a second site, a cacao plantation called Finca La Central that was being rehabilitated, plants were intensely attacked by the adults, with up to 20 individuals per plant (August, 2008, Fig. 1). The understory had been cut back in July, and there were numerous re-sprouts of *H. latispatha*, which were the target of attacks by *Spaethiella*.

Seasonality. Adults (Fig. 2) were present throughout the dry season. Larvae were also present in the dry season, but in much lower numbers. Both larvae and pupae retained the bird's nest type exuviofecal shield that is diagnostic for Hemisphaerotini.

Spaethiella species 2 (Fig. 3–6)

Collecting Data. Ecuador, Los Ríos Province: Estación Experimental Tropical Pichilingue, Sector La Isla, 16–VII–2008, 25–X–2008, R.W. Flowers, R. Troya. This is a new species that will be described by Lukas Sekerka (L. Sekerka, pers. comm.).

Host plant. Cyclanthaceae: *Carludovica* sp. (Fig. 3, 5). The host is well known as the "Panama hat" plant, as it is the source of fibers for the famous hat (which is actually manufactured in Ecuador) (Wikipedia contributors 2009). *Carludovica*, known locally as "toquilla," is also used for covering house roofs in western Ecuador (Fig. 11).

Hemisphaerotines have been previously recorded on Arecaceae, Heliconiaceae and Sterculiaceae (Chaboo 2007, and citations therein), and our record here of a cyclanthaceaous host represents a **new plant family and genus record**. Adults, larval cases (Fig. 4–6), and pupae were found on the same plant. Feeding damage comprised long, very narrow trenches between leaf veins; when several trenches oc-

Figure. 1–6. *Spaethiella* with their hosts. **1)** *Spaethiella* sp. 1 (Body length ca. 4mm), larvae and pupae on *Heliconia latispatha*. **2)** Adult of *Spaethiella* sp. 1 with trenching feeding pattern. **3)** *Carludovica* sp., host of *Spaethiella* sp. 2. **4)** *Spaethiella* sp. 2, larva with bird's nest fecal case. **5)** *Spaethiella* sp. 2, larvae and pupae, and window panes produced from trenching feeding pattern. **6)** *Spaethiella* sp. 2, adult (Body length ca. 5mm).

curred in proximity, "window panes" were created (Fig. 5). Several larval cases were found with pupal exuviae inside. In two cases, tiny brown spiders were found to be sheltering next to the pupal exuviae.

Seasonality. Adults (Fig. 6) were present throughout the dry season, often on very degraded leaves. Both larvae and pupae retained the bird's nest type exuvio-fecal shield that is diagnostic for Hemisphaerotini.

Figure 7–13. *Aslamidium* and their Marantaceae hosts in Ecuador. **7)** *Aslamidium capense* adult (Body length ca. 6mm). **8)** Feeding damage of *A. capense*. **9)** EETP technicians R. Troya and J. Cedeño under a mature *Calathea lutea*. **10)** *Calathea majestica* (with author R.W. Flowers). **11)** Local house with roof made of *Calathea* and *Carludovica* leaves. **12)** *Aslamidium semicirculare* adults (Body length ca. 5 mm) feeding on young *C. lutea* leaf. **13)** Underside of leaf of *C. majestica* damaged by beetle chewing.

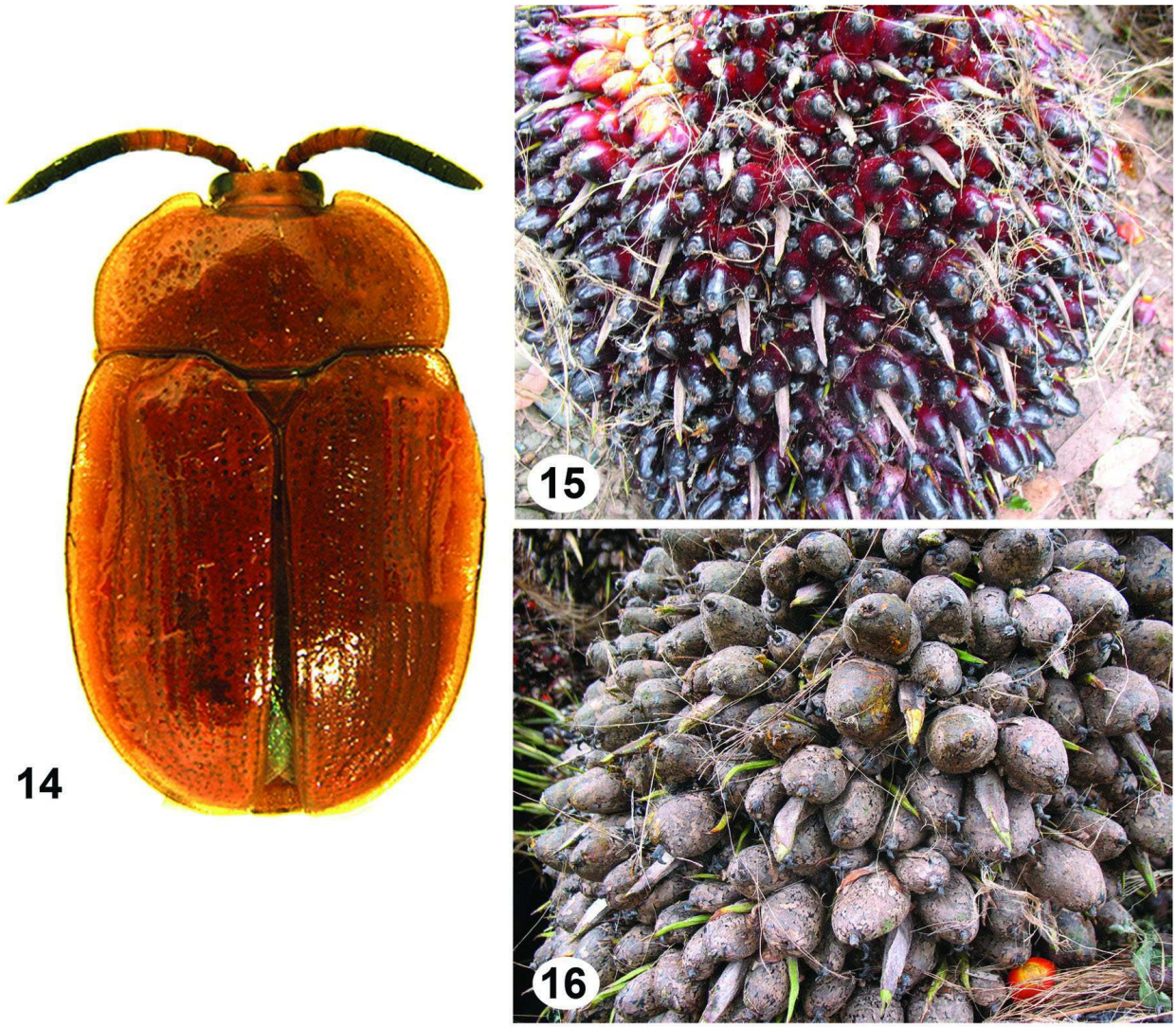

Figure 14–16. *Demotispa elaeicola* and its host, *Elaeis guineensis* (oil palm). **14)** Adult (Body length ca. 5 mm) (photo by M. Haseeb). **15)** Undamaged fruit. **16)** Heavily damaged fruit.

Tribe Imatidiini Hincks

***Aslamidium capense* (Herbst)** (Figure 7–8)

Collecting data. Ecuador, Pastaza Province: near Puyo, 3–VIII–2008, R.W. Flowers, J. Calles.

Host plant. *Calathea* sp. (Marantaceae). Two to three adults were found per leaf on numerous leaves, but no larvae were present. This is the **first host record** for this species.

***Aslamidium semicirculare* (Olivier)** (Figure 9–13)

Collecting data. Ecuador, Los Ríos Province, Estación Experimental Tropical Pichilingue, sector La Isla, ex *Calathea lutea* Schult. (Marantaceae), 12–VI–2007, 15–VII2007; sector Santa Rita, ex *Calathea lutea*, 19–VII–2008, 23–VII–2008, 15–VIII–2008, R.W. Flowers, R. Troya, J. Cedeño.

Host plants. Calathea lutea is a very large plant at maturity, with leaves measuring three to four meters high (Fig. 9). It is locally called "bijao" and is used by people in the countryside of western Ecuador for thatching roofs (Fig. 11) and for wrapping food eaten in the field (J. Cabanilla, pers. com.).

This cassidine species was found feeding only on the younger leaves less than a half meter in height. Adults were found on the upper side of leaves growing at heights of 44mm to 160mm. Feeding scars measured 1.5mm wide and from 1.5mm to 28mm long. No *Aslamidium* individuals or their diagnostic feeding scars were found on the older leaves of the mature plant, which are noticeably thicker than the earlier leaves and are covered with a thick waxy secretion on the undersides. No eggs or larvae were observed, and the number of beetles decreased between the first and last observations, corresponding to the drying out of the habitat.

Aslamidium semicirculare was also found on another species of *Calathea*, *C. majestica* (Linden) H. Kenn. (Fig. 10, 13), which was growing in dense shade in a stand of mature second-growth forest at Pichilingue. Leaf scarring and observed behavior of the beetles was similar to those on *C. lutea*. These are the **first host records** for this cassidine.

Seasonality. Adults were present throughout the dry season. Numbers on leaves at Pichilingue decreased between July and August, but had somewhat increased again between August and late October 2008. No larvae have been found on either host plant.

***Demotispa elaeicola* (Aslam)** (Figure 14–16)

Collecting data. Ecuador: Pichincha Province, Estación Experimental Santo Domingo, La Concordia, 20–VI–2006, R.W. Flowers, M. Martínez, M. Navarrete. The habitat comprised plantations of rubber, soybean and palms. Adults (Fig. 14) feed on both fruits and the newly emerged rachis of young palms, but larvae were found exclusively on the fruits (L. Maldonado, pers. comm.) and did significant damage (Fig. 15–16). The larva and pupa are free-living, slug-like in shape and light tan in color.

Host plant. Arecaceae: *Elaeis guineensis* Jacq. (Aslam 1965). This is the first record of a cassidine feeding on fruits. Oil palm has been cultivated in Ecuador since 1953, and studied by INIAP since the 1960's (L. Maldonado, pers. comm.). Damage by *D. elaeicola* causes a 2% reduction in oil extracted from palm fruits, according to some palm oil extractors (Ortega et al. 2006), and a 5-year study is planned to examine the agricultural problem posed by this cassidine species.

Seasonality. This species is present year around but is more numerous at the beginning of the rainy season (December) (A. Romero, pers. comm.).

Discussion

The data presented here raise two interesting points. First, it is perhaps unsurprising that in two cases where native cassidines feed on locally economically important plants (*A. semicirculare* on *Calathea* and *Spaethiella* on *Carludovica*), humans and beetles coexist in a relation of non-competitive exploitation. On the other hand, in the intensive monocultures of the introduced African oil palm, feeding damage by the native *D. elaeicola* has risen to economically significant levels.

Second, the fruit rasping feeding pattern discovered in *D. elaeicola* is recognized as a new trophic guild for Cassidinae. Cassidinae *s.l.* encompasses two historically recognized subfamilies, Cassidinae *s.str.* Gyllenhal (tortoise beetles) and Hispinae *s.str.* (leaf miners). The tribes Cephaloleini and Arescini have been called the rolled-leaf hispines due to their habit of living and feeding in not fully opened leaves of various Zingiberales (e.g., gingers, heliconias). As biologies of more cassidine species have been uncovered, it became apparent that larvae are far more diverse in their feeding patterns; Chaboo (2007: 43) recognized six trophic guilds for immature stages of Cassidinae: leaf-shelter builders, stem miners or borers, cryptic rolled-leaf feeders, bract scrapers, leaf miners, and open folivores. Chaboo (2007) omitted a report (Anonymous 2004) of oil palm fruit rasping in another cassidine, *Imatidium neivei* Bondar. Here we recognize fruit rasping as a seventh feeding guild, displayed by *D. elaeicola* and *I. neivei,* distinguished by food source. *Demotispa* Baly and *Imatidium* Fabricius are both members of the intriguing tribe Imatidiini Chapuis. This tribe poses a phylogenetic and taxonomic challenge in Cassidinae, and it has been synonymized with Cephaloleini in the past (Monrós and Viana 1947; Staines 2002). Larval feeding is diverse, with external folivory, cryptic feeding within constructed leaf shelters, and now fruit rasping.

Seven cassidine genera — *Alurnus* Fabricius, *Calyptocephala* Chevrolat, *Coelaenomenodera* Blanchard, *Delocrania* Guérin-Méneville, *Promecotheca* Blanchard, *Imatidium,* and *Spaethiella* — have

been documented as pests of oil palms (see Chaboo 2007: Table 4 and citations therein; Córdova-Ballona and Sánchez-Soto 2008). *Demotispa elaeicola* is now added to the list of oil palm pests.

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